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Digital Transformation in *Endek* Weaving Tradition

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Endek adalah tekstil tradisional yang diproduksi di Pulau Bali dengan menggunakan teknik single ikat, motif pada benang dihasilkan dengan cara mengikat benang pakan pada motif yang diinginkan. Tenun Endek merupakan salah satu budaya yang diwariskan dari generasi ke generasi. Menghasilkan motif pada Endek, membutuhkan kreatifitas dan proses perhitungan yang cukup rumit, sehingga tidak banyak orang yang menguasai kemampuan membuat motif dan menghitung benang secara bersamaan. Salah satu cara untuk memudahkan penenun untuk mendesain sekaligus menghitung benang adalah dengan menciptakan sebuah aplikasi yang mampu menyediakan kemampuan untuk mendesain sekaligus menghitung jumlah benang yang dibutuhkan, sehingga pengguna hanya fokus untuk mendesain motif. Untuk memahami algoritma pembuatan tenun Endek, maka peneliti melakukan penelitian di lapangan terlebih dahulu. Setelah mendapatkan variabel pembuatan tenun Endek dari lapangan, kemudian variabel tersebut diterjemahkan kedalam bahasa pemrograman untuk membentuk aplikasi. Aplikasi ini diciptakan dengan user interface yang sederhana agar mudah digunakan bagi orang yang tidak familiar dengan teknologi. Penciptaan aplikasi ini berkontribusi pada efisiensi pembuatan motif pada pertenunan yang biasanya dilakukan dalam satu hingga dua hari, dengan adanya aplikasi ini mampu mempersingkat waktu pembuatan desain menjadi satu hingga dua jam.

Kata Kunci: Endek, aplikasi digital, ikat, efisien

Digital Transformation in Endek Weaving Tradition

Endek is a traditional textile produced on the island of Bali using a single ikat technique, the motif on the yarns is produced by tying the weft yarns to the desired motif. Woven *Endek* is a culture that is passed down from generation to generation. Generating motifs on *Endek* requires creativity and a fairly complicated calculation process, thus not many people master the ability to make motifs and count yarns simultaneously. One way to make it easier for weavers to design and count yarns is to create an application that is able to provide the ability to design and calculate the number of yarns needed so that users only focus on designing motifs. To understand the algorithm for making *Endek*, the researchers conducted research in the field first. After examining the variables for making woven *Endek* from the field, then the variables were translated into a programming language to form an application. This application was created with a simple user interface to make it easy to use for people who are not familiar with the technology. The creation of this application contributes to the efficiency of making motifs on weaving which is usually done in one to two days. This application is able to shorten the time of making designs to one to two hours.

Keywords: Endek, digital application, ikat, efficient

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INTRODUCTION

Traditional textiles owned by each region in Indonesia have their own uniqueness, with materials and motifs in accordance with the culture and materials available in each region. This causes traditional Indonesian textiles to be rich in a variety of motifs and various textile-making techniques. However, the process of making textiles is passed on from generation to generation through oral tradition—which is an intangible cultural heritage—so that not all motifs and textile-making processes are well-documented. Preserving oral culture can be done by digitizing the oral culture. It is explained in the guidelines for the preservation of Digital Heritage that, "digital format includes text/documents, databases, photos, videos (moving and immovable images), website pages, applications, and various other digital formats," (National Library of Australia, 2003, p.13).

The culture of knowledge created by humans is increasingly converted into digital form to support efforts to preserve cultural traditions that are starting to disappear. The weaving process is one of the most tangible manifestations of intangible cultural heritage. The focus is on preserving the cultural creation itself and the ways in which the skills that go with it are transmitted over time, particularly within communities that share these traditions. To support the preservation of traditional Indonesian textiles, the Ministry of Education and Culture of the Republic of Indonesia in 2017 recognized thirty-three traditional textile products in Indonesia as intangible cultural heritage. The thirty-three recognized textiles are still less than half of the traditional textiles in Indonesia. Therefore, documenting and digitizing the rare traditional fabrics is urgently needed because the woven fabric is one of the craft products made as a medium to translate thoughts and feelings from within humans into signs or symbols that are used collectively (Prayatna, 2021).

One of the traditional fabrics produced on the island of Bali is woven *Endek* (Rajasa, 2010). This woven *endek* is produced using a single *ikat* technique, where the yarns are given a motif only on the weft yarns, while the warp yarns use yarns without a motif. Weft yarns are yarns that are threaded across the warp yarns when weaving the fabric, while warp yarns are woven yarns that are arranged in a row (usually longitudinally) and immobile (tied at both ends), into which the weft yarns are inserted.

This woven *endek* fabric has been registered as a Communal Intellectual Property of Traditional Cultural Expressions with EBT number: 12.2020.00000085. Based on this, the woven *Endek* fabric is a creative cultural heritage of the Balinese people that must be preserved and protected. To support the preservation of intangible cultural heritage, the manufacture of woven *Endek*, the Balinese government issued a Bali Provincial Regulation which regulates the strengthening and promotion of Balinese Culture, namely the Regional Regulation no. 4 of 2020. Furthermore, the detailed rules that govern the traditional Balinese textiles are stipulated in the Circular of the Bali Governor, SE no 4 of 2021 regarding the use of Balinese woven *Endek* fabrics / Balinese Traditional woven fabrics in various activities every Tuesday. This brings a breath of fresh air to the traditional Balinese textile weavers, especially the Woven *Endek* Fabric as it gives the weavers a breath of fresh air to advance their production. With this opportunity, woven *endek* weavers are required to always be innovative and creative in designing *endek*, in addition, the level of accuracy and precision is also needed in designing *endek* to determine the desired amount of material. However, limitations in the design process, which has been done manually so far, have not been able to provide a forum for exploration for weavers, so most weavers only follow the trending motifs on the market.

The process of making woven *Endek* has quite long stages, but what will be converted into digital transformation focuses on the design stage. *Endek*'s design process is a process that has many stages and takes a long time. At this stage, innovative and creative design skills are needed, currently, this process can be done digitally with a variety of generally available software, such as Corel Draw, Adobe Photoshop, and others, but they have not been able to specifically help woven *Endek* weavers to design and calculate the exact number of yarns from the design created, so the need for an application that can be used to help the weavers for woven Endek is very much needed.

The woven *Endek* design process is only carried out on the weft side. The weft design process consists of several stages, namely making a motif design, calculating the number of yarns needed according to the motif that has been made, then moving the specified strands into the *penamplikan.* The designs that have been made are then printed according to the width of the yarn so that the process of transferring designs into yarn is easier.

Most of the problems that occured are the doubts of weavers or motif makers to explore in designs for new products, given the concern that the finished

woven *endek* fabric will not be as expected. This is because the technique for designing the woven *Endek* motif is still manual, so the process takes a long time. In addition, the calculation of the number of yarns according to the desired motif must also be calculated manually.

Therefore, technological collaboration is needed that puts forward the digitalization process in aspects of daily life and also in industrial and production processes. Regarding the digital transformation process in the field of design, so far design activities are closely related to the use of technology, especially computers and software. The output in the form of digital data generated by the technology is then used in the design embodiment process, this shows that the design activity has been included in the digital transformation section. So it can be said that the designers already have digital thinking in their mindset, for example, the application of technology in the textile manufacturing process has also been applied before, such as airbrush coloring techniques on textiles (Waty, et.al, 2016; Radiawan, 2016).

But on the other hand, there are also design activities that are carried out manually. The traditional design process is passed down from generation to generation through verbal culture. The complexity of the traditional design process is starting to be abandoned by the younger generation and this has an impact on reducing local wisdom that should be preserved. Entering this all-digital era, it is a challenge for all parties involved in the design field to be able to maintain and preserve the traditional design process. On the one hand, cultural preservation and conservation need to be carried out in accordance with what the previous generation did, but on the other hand, it is time to think about the sustainability of traditions to transform towards user-friendly digitalization.

The development and changing times from globalization to digitalization have become a formidable challenge in maintaining a traditional design process. The younger generation sees the complex design process and takes a long time to produce a work as unattractive and does not follow trends. It is feared that if this continues, it is very likely that the intangible knowledge will slowly disappear. In addition, a lot of intangible knowledge is passed down from generation to generation through verbal processes and has not been properly documented. To attract the younger generation to be interested in preserving their culture, the unification of digital trends with their own culture is one solution that can be offered.

The purpose of this article is to explain how digital transformation is in the traditional culture of making woven *Endek ikat* designs, especially in the Woven *Endek* Design process.

RESEARCH METHODS

The method used in the digital transformation process in the traditional woven *Endek* culture is to use a sequential mixed method, (added explanation by Cresswell) which starts by firstly understanding the conditions and culture of the *Endek* weaver group, then followed by a simulation process to make the application prototype for *Endek* design process. The division of activities consists of two stages, namely:

A. Stage 1 - Understanding

The researcher conducted the first stage in the field by conducting interviews and observations in a weaving center to understand how *Endek*'s design is made in the field. The research location is the Astiti Weaving center which is located in the village of Gelgel Klungkung. After obtaining permission to conduct research from the weaving center owner, the researcher then selected participants to be interviewed and observed. The research stage is presented in Figure 1.

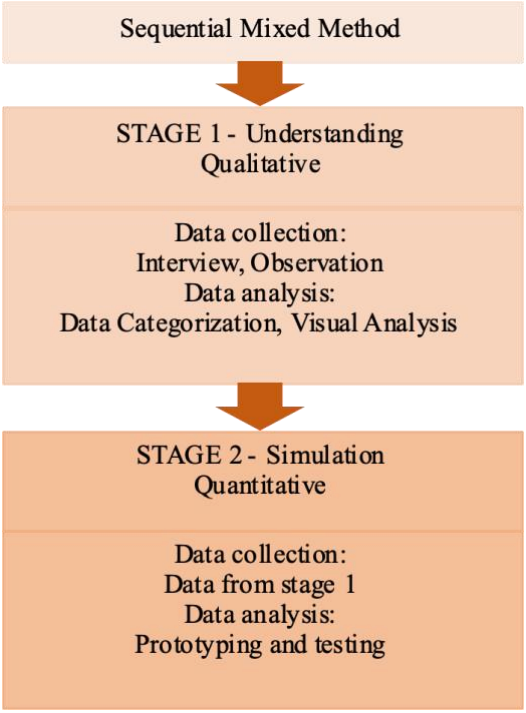

Figure 1. Research Stages
Source: Pebryani, 2021

The interviews were conducted with 8 participants consisting of 2 weavers, 2 motif makers, 2 people who tied the motifs on the yarns, and 2 people who

transferred the yarns to the *penamplikan*. Interviews and observations were conducted 16 times. Researchers traveled to Astiti Weaving and spent time with participants to understand their culture and procedures for making *Endek*, especially in the design section (making motifs, calculating yarns, transferring yarns to the *penamplikan*, transferring motifs to yarns, and binding motifs). The data obtained during the interview and observation process was then typed in the form of a transcript and then categorization was carried out to understand the flow and calculations of the stages and design process.

The understanding stage is an important stage and takes quite a long time, but can minimize misinterpretation in the digital transformation process. At the initial stage, researchers are required to get closer to weavers or design actors in weaving, then after making introductions, they continue to study the traditions of the weavers, especially in the field of *Endek* design. Spradley (2016) stated that researchers must understand 3 basic things that people do (cultural behavior), what people know (cultural knowledge), and what people use and make (cultural artifacts)" (p.10). Behavior and design results (artifacts) are closely related and easy to observe. The behavior and results of these design products are also closely related to an invisible or tacit layer, namely the knowledge of the local community (cultural knowledge). According to Spradley (2016) "people learn their culture through repetition" (p.13), and to understand this repetition, researchers must observe what people do and use and listen to what people say. Thus, to understand the traditional design process, researchers are required to go into the field in order to be able to understand the knowledge possessed by the local community. Pebryani (2019) also added that to get complete information, researchers must always regard the object of research as a teacher, and researchers should act as students who want to learn about their culture, this is because, when comfort is formed between researchers and research objects, the process of understanding and learning will take place more relaxed, and the willingness of the research object to provide complete information will be achieved (p.35).

B. Stage 2 - Simulation

After understanding the design process from the field and getting the results from the field study, the results of the research are used as data for the simulation stage. According to Somer (1991), "the steps in carrying out the simulation are: making a model or prototype, running the prototype, and testing or analyzing the results of the prototype" (p.32).

The data from the first stage, which consists of the stages of the *Endek* design process and its variables, is then converted into pseudocode. Pseudocode is a short description of a computer programming algorithm that uses the structural conventions of a programming language and is intended to be read by humans, not by machines. After determining the pseudocode, then the next process is to create a prototype by translating the algorithm that has been written in the pseudocode into a web-based application. The reason for choosing a web-based application is to make it easier for users to directly use the application when there is an internet network, without an installation process, and can be run on Windows or iOS environments.

DATA ANALYSIS AND INTEPRETATION

Traditional textile manufacture on a weaving machine is a meeting between the warp (dihi) and weft yarns. The treatment and procedure of the warp and weft yarns in the *Endek* weaving consist of approximately 14 stages (Figure 2).

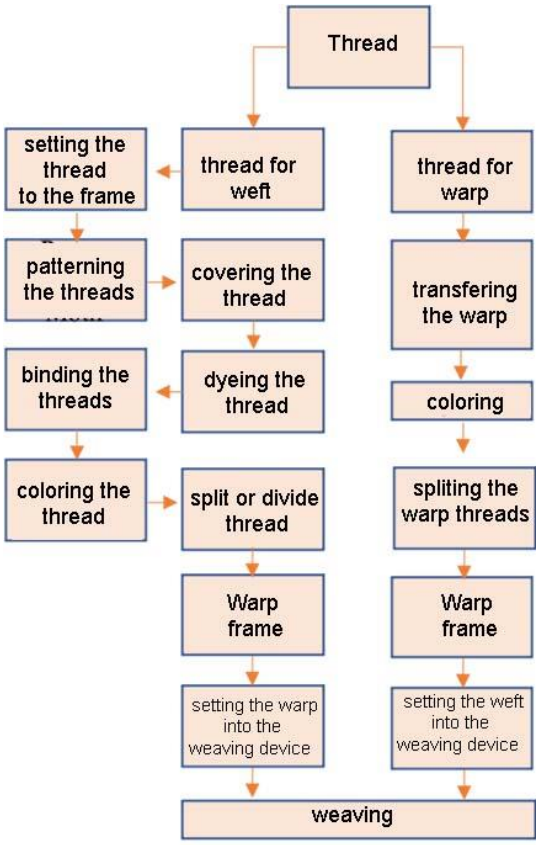

Figure 2. Stages of Making *Endek*
Source: Pebryani, 2021

Warp Yarns (dihi)

The process required for warp yarns (dihi) consists of 6 stages (Figure 2). Warp yarns are yarns that lie vertically on non-machine looms (ATBM). The process of making warp yarns begins with singing or storing the yarns into a tool called *molen*. Warp yarns are generally yarns with one basic color, where the yarns when purchased are still white and then soaked in a mordant solution before adding the dye. The dyes used mostly use synthetic nandrin type dyes, with better quality and less likely to fade. The warp yarns usually use 80/2 cotton yarns, it takes approximately 3650 strands of yarns in 50 turns, this amount of yarns is usually used to produce 85 m of cloth.

After the yarn is dyed, it is continued with a drying process which takes approximately 10 days, then after drying, it is continued with a process called *menpem benang*. Then it is proceeded with the injection process, inserting the yarns into the *guun* which takes about two days.

Weft Yarns

As described earlier, the process of making motifs in woven *Endek* is carried out only on weft yarns, so the weft yarns process takes longer and is more complicated than warp or *dihi* yarns. The weft used is usually 64/2 cotton or silk yarns. The *menpem benang* process requires a calculation that is determined by the design of the motif to be made, therefore an explanation of the making of the motif will help explain the *menpem benang* process.

Making motif designs on *Endek* requires various skills and understanding, starting from an understanding of the repetition of the motif, then understanding that the *Endek* motif design will only be made or tied to the weft yarns (horizontal yarns) while the warp yarns (vertical yarns) is without a motif and is of one color. So that the combination of yarns with motif and plain yarns as the basis will make the woven *Endek*. Because the motifs in woven *Endek* are only on the weft, the resulting motifs on the Endek motif have certain characteristics, namely, the motif is slightly striped or has a shifting impression.

This character gives rise to the uniqueness of the yarns calculation procedure for *Endek* weaving. The motif design process is carried out first before determining the number of yarns, the more complicated and detailed the motif created, the more detailed the calculation required. In addition, most of *Endek*'s weaving is a repetition of a core motif made by the motif maker. The following are the variables needed to pay attention to the design of the *Endek* motif:

1. The size of the *penamplikan* (where the *endek* yarns are moved). The commonly used size is 100 cm x 108 cm
2. In the design drawings, it is important to take into account the distance between the ties to one another at least 0.5 cm so that the dyed color can enter.
3. The number of *pempenan* is As1, As2, As3, and As4, the most commonly used is As4.
4. In 1 cm of yarns, 8 turns of yarns are required, and each round consists of 4 strands.
5. It is common to use 4 pins (As4), the *pempen* yarn in one *bulih* can be used for 8 times, so the image multiplier is 28/8 = 3.5 times. So if the motif uses As4, then the number of *pempenan* needed is 28 times 3.5 which is equal to 98 *bulih*. Each bulih has about 70 to 80 strands of yarns. Number 28 is the size of the depiction of the core motif, as described in the next number.
6. *Endek*'s overall design image is a repetition of the core motif; to make the core motif, only an area measuring 28x46 cm is needed, then the core motif is repeated by reflection (mirror) or translation (multiplying the number to the right or left side of the core motif image.

From the variables that have been found in the process of making the woven *Endek* motif design, then these variables are converted into a programming language to make visualizations that are easy to use for people who are new to technology. This application is intended for weavers or motif makers who do not all understand the use of technology. On the basis of this understanding, a simple application is made that contains all sizes on one screen or one level.

Application Development

The application made is a web-based application so that weavers and motif makers can easily use them. In addition, this web-based application does not require installation but requires an internet network. Through this application users are able to change colors and design motifs on the template provided, then the motifs made are then translated into a visualization of the overall design and also into the calculation of the number of yarns (see Figure 3).

This application makes it easy for users to explore designs and if an error occurs, it will be easier to remove. In addition, a database is also provided, so that users can save designs that have been done and then reuse them to add new designs or combine designs that have been made previously (see Figure 4).

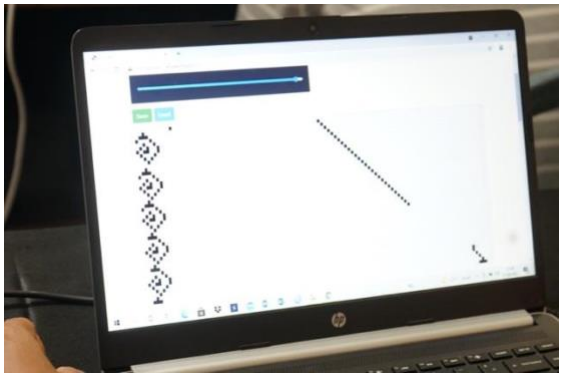

Figure 3. Application for making Endek motifs
Source: Pebryani, 2021

Figure 4. Weavers practice using applications for making Endek motifs
Source: Pebryani, 2021

After creating a design, at the bottom, the user can see how the design is translated into a yarns count as shown in the image below (Figure 5). The resulting motif is 28 cm in size (Figure 6), then enlarged using As4 size, 28 multiplied by 3.5 times to make 98 *bulih*.

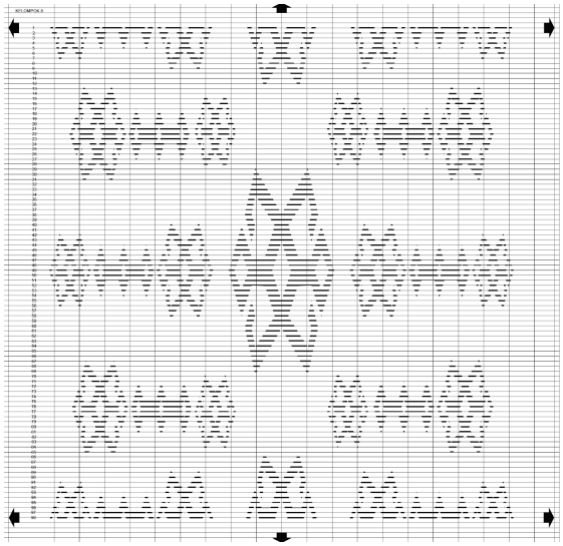

Figure 5. Calculation of motifs to yarns
Source: Pebryani, 2021

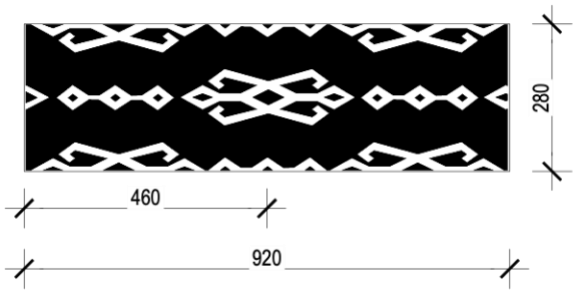

Figure 6. Motifs to yarns
Source: Pebryani, 2021

After producing a motif with the size of the appropriate yarn, then (Figure 5) the motif is printed out on the banner to then be applied to the *pempen* yarns on the *penamplikan* with a total of 98 *bulih.* Then the results in Figure 5 are printed on a 1:1 scale, the resulting motif is then applied to the yarns. The resulting size on the yarn design with the prepared *penamplikan* has the same size or the same scale so that when the motif is printed, the size will be the same as the number of yarns that have been inserted in the *bulih penamplikan*, as shown in Figure 7 below.

Figure 7. Application of motifs into yarn
Source: Pebryani, 2021

CONCLUSION

Digital transformation in the form of *Endek* design applications with user interfaces that are easy to understand for people who are unfamiliar with the

technology is a solution that can be offered to *Endek* motif makers to improve performance in designing *Endek*. Through cultural understanding (indigenous knowledge) at the Endek manufacturing center, indigenous algorithms can be found. These algorithms were then translated into an *Endek* motif design application. This indigenous algorithm is not only used in the manufacture of woven *Endek* but also in other traditional arts, one of which is the tradition of making Balinese dwellings (Remawa, 2021). This digital application formed from the algorithm for making woven *Endek* is able to increase the efficiency of making *Endek* where the design process for making motifs which initially took one to two days, can be shortened to only about two hours.

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